ON Semiconductor

User Guide for

FEBFL77905_L83L08A

FEBFL77905_L83H08A

Evaluation Board

8W AC LED Driver

Featured Fairchild Product:

FL77905

Direct questions or comments about this evaluation board to: "Worldwide Direct Support"

Fairchild Semiconductor.com

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This user guide supports the evaluation kit for the FL77905. It should be used in conjunction with the FL77905 datasheet as well as Fairchild's application notes and technical support team. Please visit Fairchild's website at www.fairchildsemi.com.

1. Introduction

This document describes a direct AC line LED driver with a minimal number of external components. The input voltage ranges of the LED driver board are classed as low-line application for 108 V_{AC} ~ 132 $V_{AC,}$ and high line application for 198 V_{AC} ~ 242 $V_{AC.}$ With a single DC output, constant current depends on the Rcs value. This document contains a general description of the FL77905, the normal configuration specification, schematic, bill of materials, and typical operating characteristics.

1.1. General Description of FL77905MX

The FL77905 is a direct AC line LED driver with a minimal number of external RC passive components. In normal configuration, one resistor is to adjust LED power, and one capacitor is to provide a stable voltage to an internal biasing shunt regulator.

The FL77905 provides phase-cut dimming with wide dimming range, smooth dimming control and good dimmer compatibility. It achieves the high efficiency with high PF and low THD which makes the FL77905 suitable for high-efficiency LED lighting systems. The FL77905 has a dedicated DIM pin which can be used with analog or digital PWM dimming.

High wattage design of the FL77905 can be implemented with multiple IC embedded in parallel for street lighting and down lighting applications.

1.2. Controller Features

- The simplest Direct AC LED Driver with Only Two External RC Passive Component
- Wide AC Input Range: 90~305 V_{AC}
- Four Integrated High-Voltage LED Constant Current Sinks of up to 75 mA (RMS) Capability
- TRIAC Dimmable (Leading/Trailing Edge)
- Analog/Digital PWM Dimming Function
- Rheostat Dimmable
- High Power Factor (above 0.98 in normal configuration)
- Adjustable LED Power with an External Current Sense Resistor
- Low Harmonic Content (THD under 20% in normal configuration)
- SOP 8LD Package
- Flexible LED Forward Voltage Configuration
- Power Scalability with Multiple Driver ICs
- Over-Temperature Protection (OTP)

1.3. Controller Internal Block Diagram

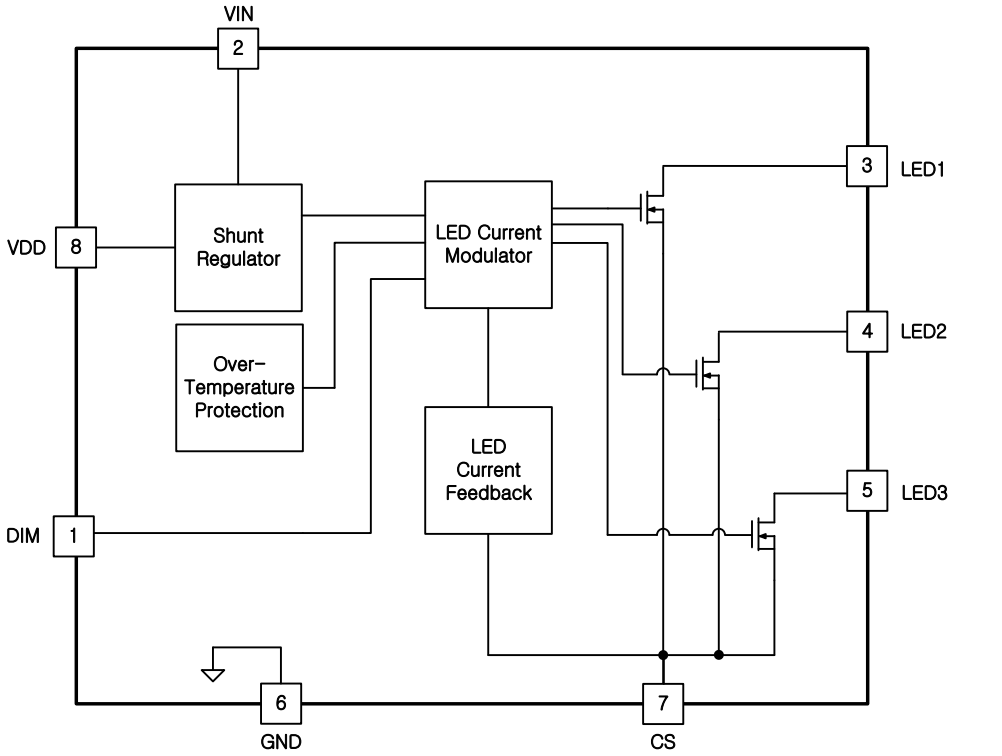

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Figure 1. Simplified FL77904 Block Diagram

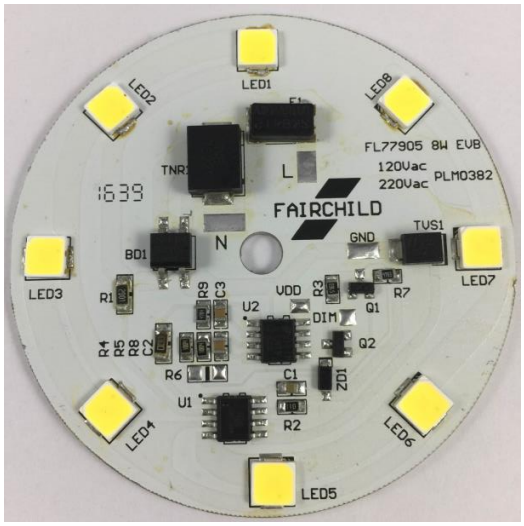
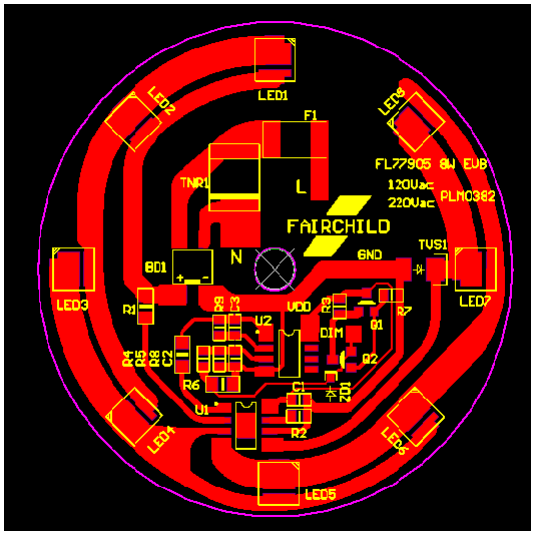
2. Evaluation Board Test Outline

Table 1. Evaluation Board Test Condition & Equipment List

Evaluation Board #	**FEBFL77905_L83L08A**	**Low-Line, 8 W**
	FEBFL77905_L83H08A	**High-Line, 8 W**
Test Date	October- 2016	
Test Equipment	AC Source: 6800 Series Oscilloscope: LeCroy 24MXs-B Power Analyzer: Chroma 6630 Thermal imager: Fluke Ti110 Light measurement: INVENTFINE CMS-8000 Photo Sensor for Flicker Index: ADMESY LM-AST-CC	
Test Items	1. Startup Performance 2. Normal Operation 3. Efficacy 4. Flicker Index 5. Power Factor 6. Total Harmonic Distortion(THD) 7. Conduction EMI	

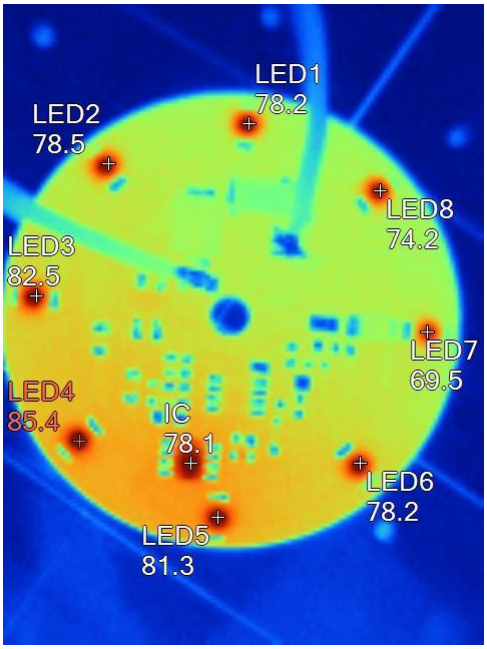
3. Evaluation Board Specifications

Table 2. Evaluation Board Specifications

EVB PHOTO	
PCB	
Diameter	60 mm
Material	Metal
Thickness	1.6 t
Input	Low-Line: 108 ~ 132 V_{AC} , High-Line: 198 ~ 242 V_{AC}

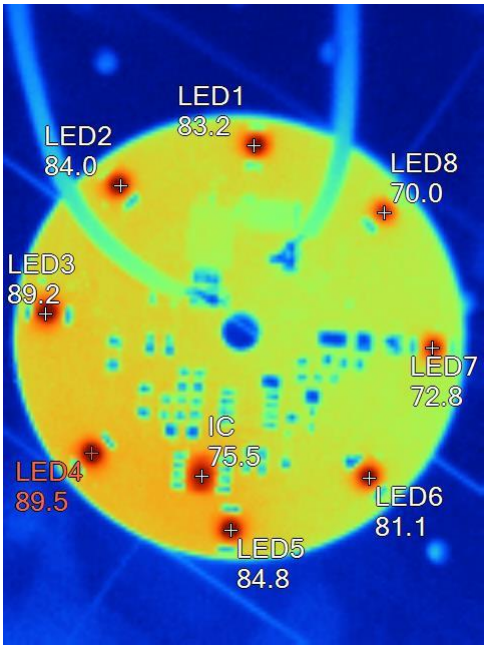
4. Evaluation Board Operating Temperature

Table 3. Evaluation Board Operating Temperature

	
Test Condition	120 V_{AC}, 30min, Room temperature. With Heat sink: 120 mm * 152 mm * 11 mm
Spot	LED1: 78.2°C LED2: 78.5°C LED3: 82.5°C LED4: 85.4°C LED5: 81.3°C LED6: 78.2°C LED7: 69.5°C LED8: 74.2°C IC: 78.1°C

Temperatures on all components at low line evaluation board are less than 86°C. The IC's temperature is lower than 79°C. Measured temperature can be changed by dimension of Heat sink.

Table 4. Evaluation Board Operating Temperature

	
Test Condition	220 V_{AC}, 30min, Room temperature. With Heat sink: 120 mm * 152 mm * 11 mm
Spot	LED1: 83.2°C LED2: 84.0°C LED3: 89.2°C LED4: 89.5°C LED5: 84.8°C LED6: 81.1°C LED7: 72.8°C LED8: 70.0°C IC: 75.5°C

Temperatures on all components at high line evaluation board are less than 90°C. The IC's temperature is lower than 76°C. Measured temperature can be changed with dimension of heat sink.

5. Evaluation Board Bill of Materials (BOM)

No.	Description	Specification	Type	Location No.	Qty.	Vender	Remark
Common Parts							
1	CHIP-RES	11 Ω	0805	R2	1		Low line
	CHIP-RES	20 Ω	0805	R2	1		High line
2	CHIP-RES	576 Ω	0805	R3	1		
3	CHIP-RES	470 kΩ	0805	R7	1		
4	CHIP-RES	1 M Ω	0805	R5, R8	2		
5	CHIP-RES	4.7 M Ω	0805	R9	1		
6	CHIP-RES	0 Ω	1206	R4	1		
7	CHIP-RES	2 kΩ	1206	R1	1		
8	CHIP- CAP	15 nF / 25 V	0805	C2, C3	2		
9	CHIP- CAP	0.1 µF / 25 V	0805	C1	1		
10	MMBT290A	SOT-23		Q1, Q2	2	Fairchild	
11	LM258AM	MDIP 8L		U2	1	Fairchild	
12	Bridge Diode	MB6S (0.5 A 600 V)		BD1	1	Fairchild	
13	Varistor	TVB7S221KR	Size3225	TNR1	1		Low line
	Varistor	TVB7S391KR	Size3225	TNR1	1		High line
14	SMD LED	32VF 42 mA	5250	LED 1~8	8	LGIT	Low line
	SMD LED	65.4VF 20 mA	5250	LED 1~8	8	LGIT	High line
15	FUSE	2 A 250 V_{AC} MF2410F1.000TM	SMD	F1	1		
16	IC	FL77905MX	SOIC 8L	U1	1	Fairchild	
17	TVS DIODE	SMBJ100CA	DO214AA(SMB)	TVS1	1	Fairchild	
18	Zener	MMSZ5241B 11V	SOD-123 2L	ZD1	1	Fairchild	
19	PCB0382 V2	60Φ	Metal	PCB	1		

6. Evaluation Board

6.1. Evaluation Board Schematic

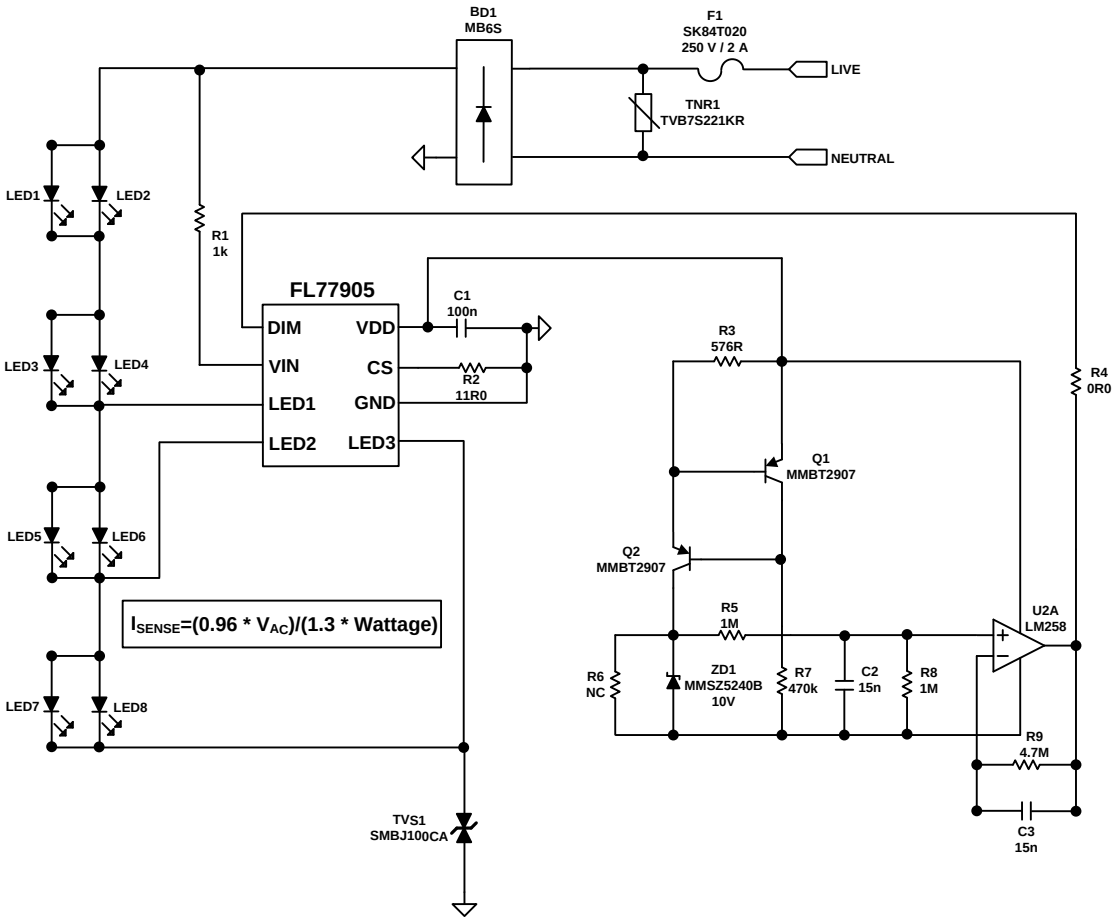


Figure 2. Typical Application Circuit of the 8 W Evaluation Board

Table 5. Evaluation Board Circuit Parameters for High-Line without SVF

Parameter	Value	Unit
Evaluation Board #	FEBFL77905_L83L08A (Low Line)	
	FEBFL77905_L83H08A (High Line)	
Input Voltage	108 ~ 132 (Low Line)	V_{AC}
	198 ~ 242 (High Line)	V_{AC}
Output Power	8	W
LED		

CCT	If(mA)	Vf(V)	CCT	If(mA)	Vf(V)
5700K(G)	42 (Typ.)	32	5700K(G)	42 (Typ.)	32
5700K(G)	20 (Typ.)	65.4	5700K(G)	20 (Typ.)	65.4

6.2. Key Performance Measurements

Table 6. Key Performance Measurements for Low-Line EVB

Input Condition	50 Hz			60 Hz		
	108 V_{AC}	**120 V_{AC}**	**132 V_{AC}**	**108 V_{AC}**	**120 V_{AC}**	**132 V_{AC}**
Power Factor	0.978	0.985	0.988	0.978	0.985	0.988
THD (%)	21.18	17.21	15.48	21.36	17.49	15.49
Pin (W)	6.65	8.03	9.27	6.66	8.01	9.26
IIN.RMS (A)	0.061	0.067	0.07	0.062	0.067	0.07
Lumen (lm)	599.7	677.5	736.8	599.5	676.5	735.7
Efficacy(lm/W)	90.9	88.2	84.2	91.0	88.2	84.3
Flicker Index	0.39	0.36	0.34	0.39	0.36	0.34

Table 6 shows the key performance measurements result for low line evaluation board from 108 ~ 132 V_{AC} at 50 Hz / 60 Hz. Power factor has enough margin from 0.9 and THD is less than 22% at the input voltage range from 108 to 132 V_{AC}. Measured Lumen can be changed by test environment such as measurement equipment type, standard sample for equipment calibration and integrating sphere type.

Table 7. Key Performance Measurements for High-Line EVB

Input Condition	50 Hz			60 Hz		
	198 V_{AC}	220 V_{AC}	242 V_{AC}	198 V_{AC}	220 V_{AC}	242 V_{AC}
Power Factor	0.984	0.988	0.990	0.984	0.988	0.990
THD (%)	18.12	15.32	14.28	18.20	15.33	14.28
Pin (W)	7.03	8.45	9.81	7.00	8.42	9.79
IIN.RMS (A)	0.036	0.038	0.041	0.036	0.038	0.040
Lumen (lm)	605	707.3	773.3	606.1	707.1	773.1
Efficacy(lm/W)	86.1	83.7	78.8	86.6	84.0	79.0
Flicker Index	0.37	0.35	0.32	0.37	0.35	0.32

Table 7 shows the key performance measurements result for high line evaluation board from 198 ~ 242 V_{AC} at 50 Hz / 60 Hz. Power factor has enough margin from 0.9 and THD is less than 19% at the input voltage range from 108 to 132 V_{AC}. Measured Lumen can be changed by test environment such as measurement equipment type, standard sample for equipment calibration and integrating sphere type.

6.3. Startup

Table 8. Startup Waveform according to Variable Input Voltage and Frequency

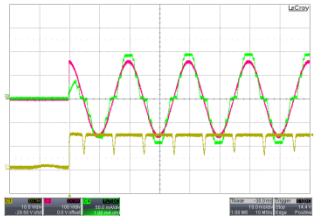
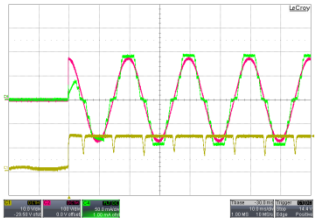
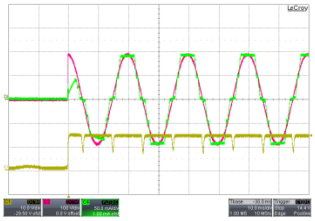
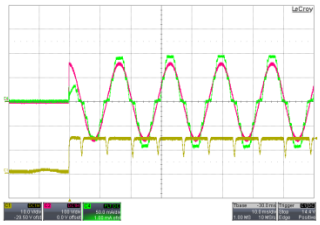
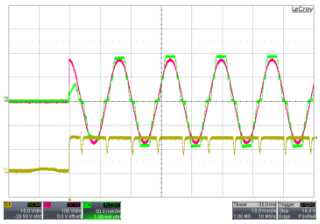
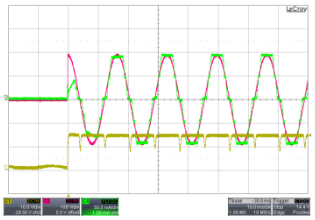
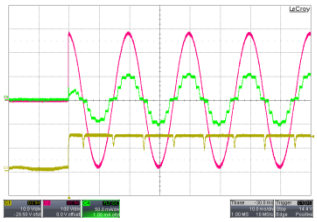
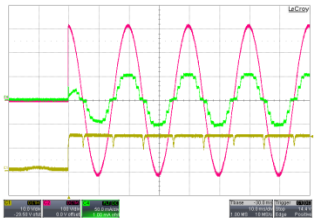
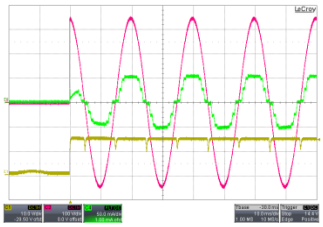
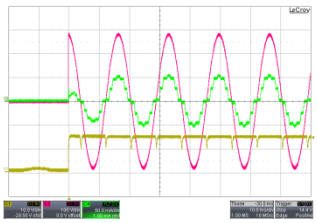
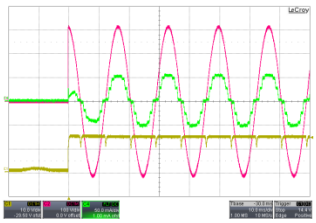
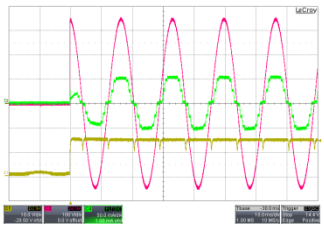
	108 V_{AC}	120 V_{AC}	132 V_{AC}
50 Hz			
60 Hz			
	198 V_{AC}	**220 V_{AC}**	**242 V_{AC}**
50 Hz			
60 Hz			

Figure 3. Ch1: VDD 10.0 V/div, Ch2: $V_{IN.ac}$ 100 V/div, Ch4: $I_{IN.ac}$ 50.0 mA/div

Table 8 shows overall startup performance at each line input voltage with 50 / 60 Hz. Input current flows immediately when input voltage is applied.

6.4. Normal Operation

Table 9. Normal Operation Waveform according to Variable Input Voltage and Frequency

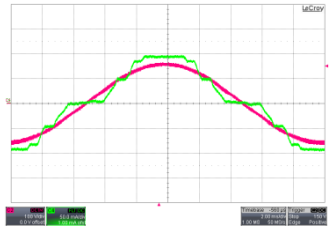
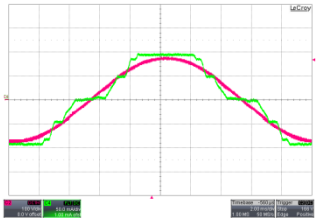
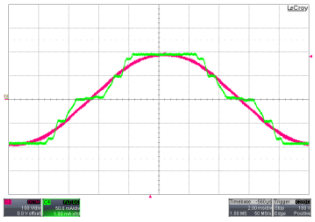
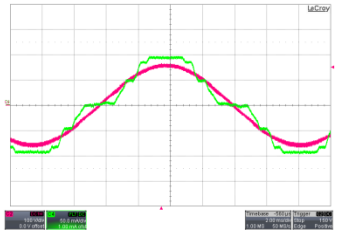
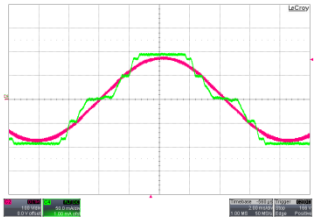
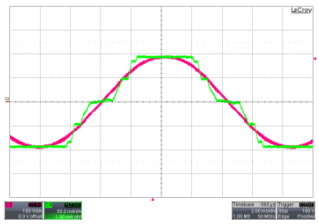
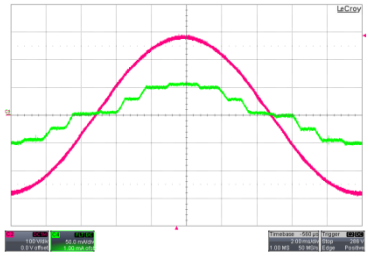
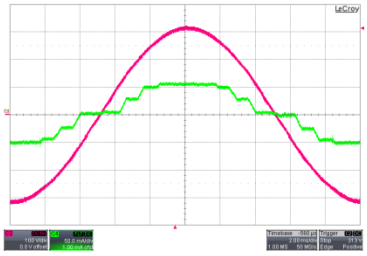
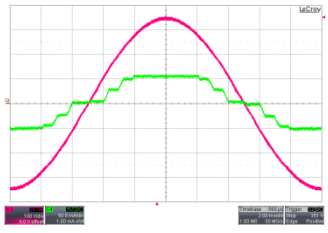
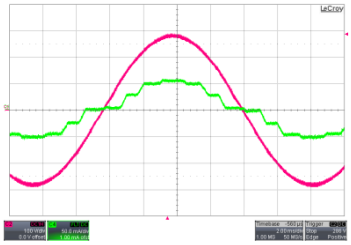
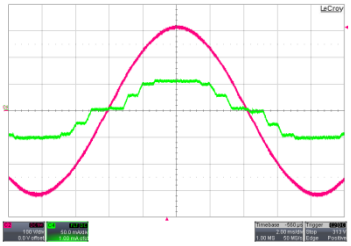
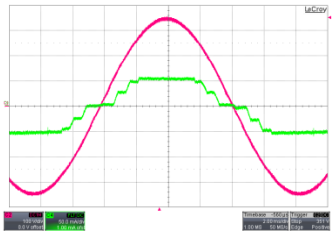
	108 V_{AC}	120 V_{AC}	132 V_{AC}
50Hz			
60Hz			
	198 V_{AC}	**220 V_{AC}**	**242 V_{AC}**
50Hz			
60Hz			

Figure 4. Ch2: $V_{IN.ac}$, 100 V/div, Ch4: $I_{IN.ac}$ 50.0 mA/div

Table 9 shows overall normal operation performance at each line input voltage with 50 / 60 Hz. When input voltage is higher than all string LED forward voltage, LED 3 pin can be conducted and its time depends on input voltage and line frequency.

6.5. Dimming Operation & Performance

Table 10. Dimming Operation Waveform at 120 V_{AC} Input Voltage

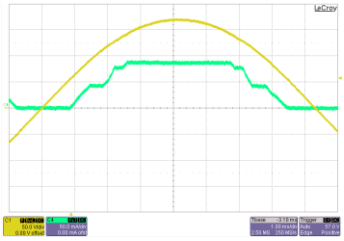
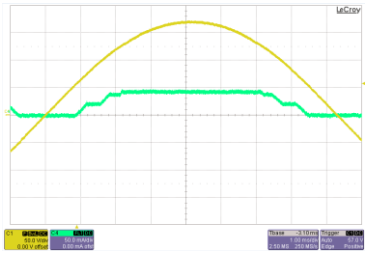
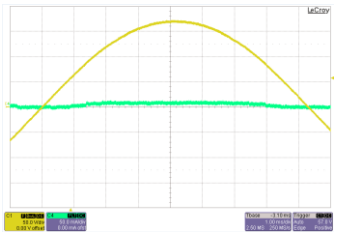
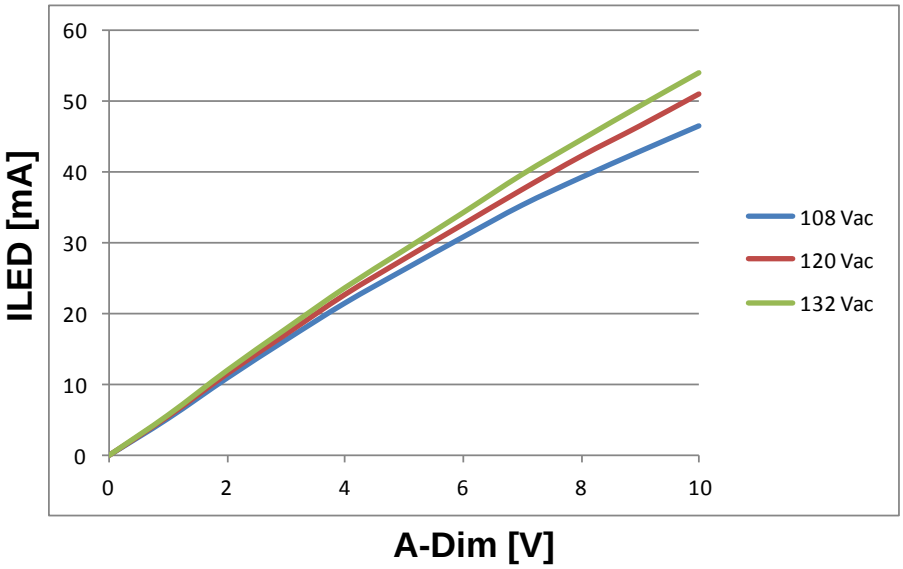
	DIM: 10 V	DIM: 5 V	DIM: 1 V
120 V_{AC} at 60 Hz			

Figure 5. Ch1: $V_{IN.ac}$, 50 V/div, Ch4: $I_{IN.ac}$ 50.0 mA/div



FL77905 analog dimming function can be implemented with a few external components.

The LED current at the rated line voltage can be adjusted within the range of 0% to 100% of the nominal current value from 0 to 10 V A-DIM signals at DIM pin

Table 11. Dimming Operation Waveform at 220 V_{AC} Input Voltage

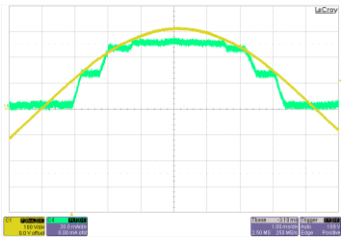
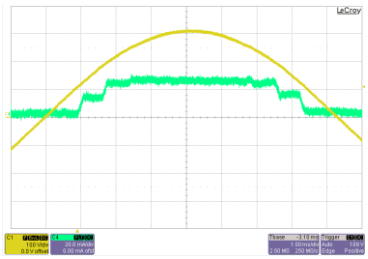
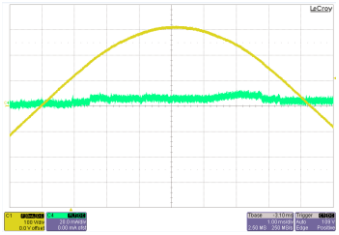
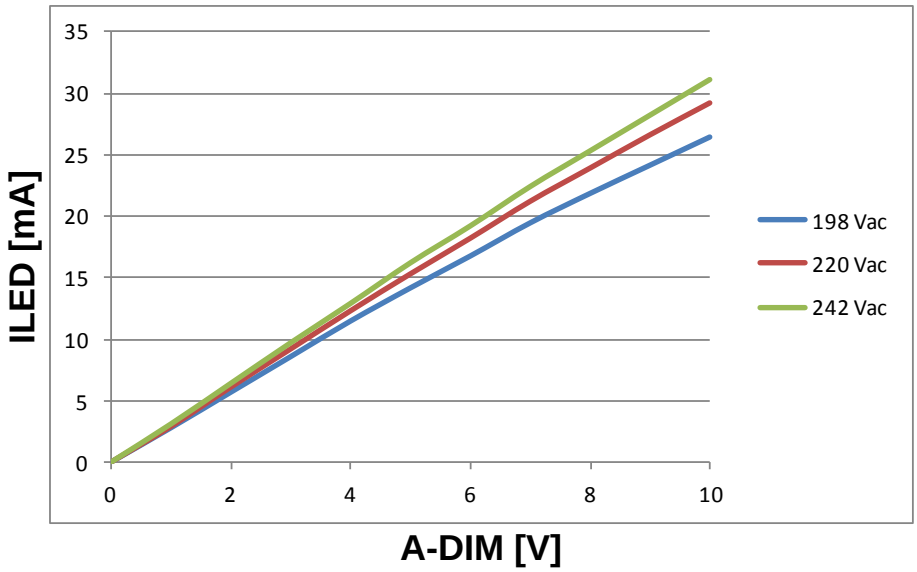
	DIM: 10 V	DIM: 5 V	DIM: 1 V
220 V_{AC} at 60 Hz			

Figure 6. Ch1: $V_{IN.ac}$, 100 V/div, Ch4: $I_{IN.ac}$ 20.0 mA/div



FL77905 analog dimming function can be implemented with a few external components.

The LED current at the rated line voltage can be adjusted within the range of 0% to 100% of the nominal current value from 0 to 10 V A-DIM signals at DIM pin

6.6. Electromagnetic Interference

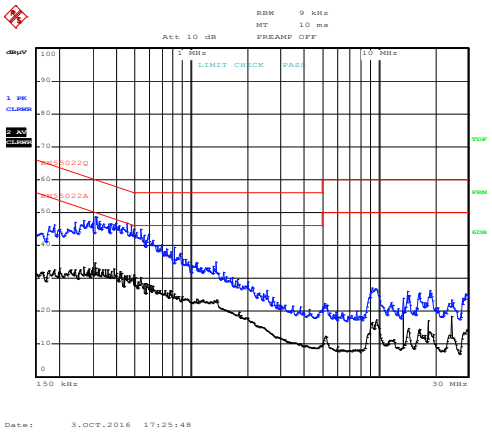


Figure 7. 120 V_{AC}, 60 Hz, <L>.

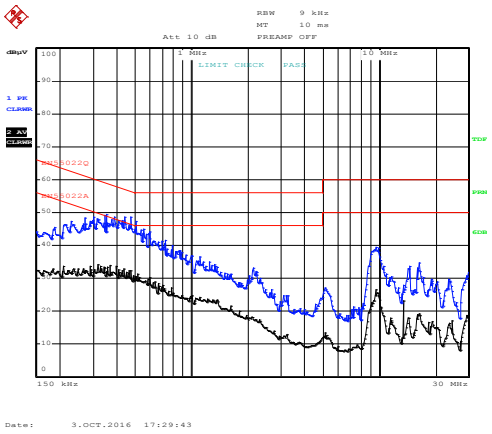


Figure 8. 120 V_{AC}, 60 Hz, <N>

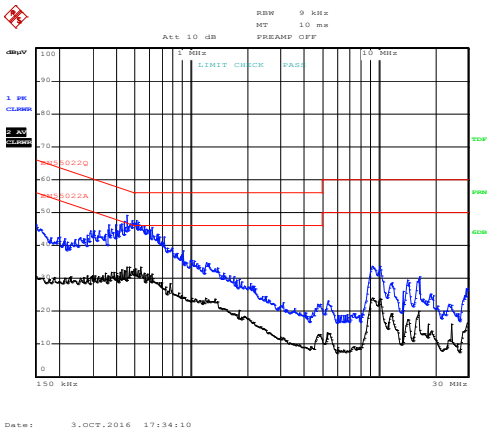


Figure 9. 220 V_{AC}, 60 Hz, <L>.

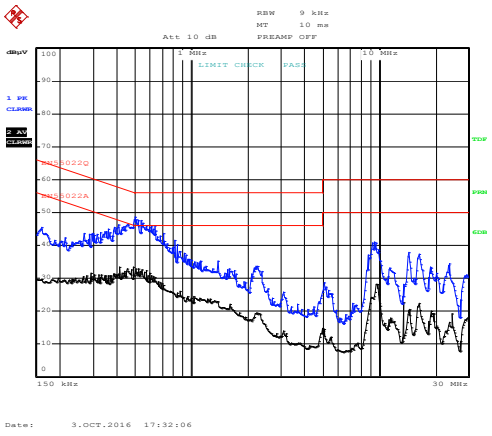


Figure 10. 220 V_{AC}, 60 Hz, <N>.

All measurements were conducted in observance of EN55022 criteria.

6.7. Surge Test

Input Voltage [V_{AC}]	Surge Type	Injection Location	Surge Level [kV]	Result
120	Line	L1 and L2	1.5	Pass
220	Line	L1 and L2	1.0	Pass

7. Revision History

Rev.	Date	Description
1.0	Nov. 2016	Initial Release

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Офис по работе с юридическими лицами:

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: info@moschip.ru

Skype отдела продаж:
moschip.ru
moschip.ru_4
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